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RADIOLOGICAL MONITORING IN THE PALOMARES ZONE (REPORT FOR FIRST HALF OF 1988)

Translated for

U.S. Department of Energy
Washington, D.C.

Translated by

SCITRAN COMPANY
1482 East Valley Road
Santa Barbara, California 93108
(805)969-2413
FAX (805)969-3439

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RADIOLOGICAL MONITORING IN THE PALOMARES ZONE
(Report for First Half of 1988)

Translation of a Spanish paper entitled "Vigilancia Radiológica en la Zona de Palomares (Informe Primer Semestre del año 1988), published in July 1988 by the Energy, Environmental and Technological Research Center of the Environmental Institute [Spain].

Translated by

S C I T R A N

1482 East Valley Road

Santa Barbara, CA 93108

C.I.E.M.A.T

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RADIOLOGICAL MONITORING IN THE PALOMARES ZONE

(Report for First Half of 1988)

July 1988

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RADIOLOGICAL MONITORING IN THE PALOMARES ZONE

PERIOD: First Half of 1988

The below activities, listed in order and by subject area, were carried out during the first half of 1988 in relation to radiological monitoring in Palomares and in accordance with the provisions of the report "RADIOLOGICAL MONITORING IN THE PALOMARES ZONE: PROGRAM FOR 1988".

1. MONITORING OF PERSONS

1.1 1987 DOSIMETRY (Finalization)

The report for the second half of 1987 gave the results obtained in the analysis of urinary excretion of Pu-239 + Pu-240 and Am-241 of the first 109 persons from Palomares who were examined in 1987.

In this first half of 1988 the analyses were completed and alpha spectrometry measurements of the urine corresponding to the remaining 40 persons examined in 1987 were finalized. Taking into consideration, however that one group of ten persons was subjected to a double dosimetric examination, the actual total number of persons who were subjected to dosimetric and medical control during that year was 139.

This last group of 40 persons was comprised of:

- 19 persons who were examined for the first time in 1987.
- 14 persons who had been examined at least once, and always with negative results.
- 7 persons who, having been examined at least once previously had presented some positive reading.

The results obtained indicate that 4 persons of this group of 40 have given positive results of plutonium in the urine and that 3 other persons have given positive results of americium in the urine. None of these persons has given a positive result for both radionuclides at the same time.

The values corresponding to the positive excretion results are:

- Pu-234+Pu-240:
  - 1 person = 1.2 ± 0.3 mBq/day
  - 1 person = 1.6 ± 0.3 "
  - 1 person = 1.8 ± 0.3 "
  - 1 person = 4.6 ± 0.1 "
- Am-241
  - 1 person = 0.78 ± 0.10 mBq/day
  - 1 person = 12.2 ± 1.8 "
  - 1 person = 5.1 ± 0.9 "

The positive results for plutonium occurred in 3 persons who had come for the first time and in 1 person who, over a period of time had presented seven negative results and who gave positive readings in 2 samples taken at Palomares at the time of the accident; consequently such results were considered to be due to external contamination of the sample.

The positive results for Americium occurred in 1 person who came to be examined for the first time in 1987, and in 2 who, in their previous examinations, had shown negative results. Two of these persons had also given negative results in an examination made earlier this same year.

None of the persons in this group presented positive results for both plutonium and americium.

In view of the existence or consideration of a single positive value of plutonium or americium urine contamination in these seven indicated persons, it is considered necessary from both the technical and scientific points of view, to conduct a new examination before being able to make a definite determination with regard to internal contamination and, if positive, the dose estimate this might signify. These 7 persons have been called for a new examination in 1988.

Direct determinations of pulmonary contamination by plutonium and americium, using a Pulmonary Raiation Counter, on the 19 persons of this group who had been examined for the first time in 1987 revealed no contamination greater than the detection limit of that equipment.

1.2 MONITORING DURING 1988

Bearing in mind the specifications corresponding to the medical and dosimetric control program for persons from Palomares, the 150-person examination campaign planned for 1988 has been broken down into two periods, one which commenced on June 7 and ended on July 13, and another which it is intended to initiate in mid-September. In accordance with the priorities established in the "RADIOLOGICAL MONITORING PLAN IN THE PALOMARES ZONE" for 1988, an initial nominal list of 138 persons was drawn up. This list includes 104 persons who, as a function of the priorities indicated in the plan, should be examined during 1988. Bearing in mind that, as has occurred in other years, some of the persons who are of specific interest to examine this year will be accompanied by others not included in the lists, the quota of persons to be covered will be 150.

In order to be able to include any other persons who, up to the end of the year, it may be of interest for some reason to examine, the nominal list, sent to the municipal authorities of Cuevas del Alamanzora will not be considered closed.

The following groups and number of persons were included in the list sent.

1-A. Persons who must take the examination during the first period.

Made up of 24 persons who have, at some time, shown positive contamination results in the urine.

1-B. Persons who have shown one positive, and several negative urine contamination results.

Made up of 7 persons.

1-C. Persons who have reached 12 years of age and have not been examined.

Made up of 20 persons.

2-A. Persons with evaluated doses who were not examined in 1987.

Made up of 31 persons.

2-B. Persons under 20 years of age, with previous negative

analyses.

Made up of 22 persons.

3-A. Persons who showed some positive result in 1966 but whose subsequent results have been negative and who have not been examined in the past three years.

Made up of 34 persons.

The population census of Palomares has still not been received. This makes it difficult to estimate and identify the persons living in this zone who have not been examined at least once.

Medical and dosimetric examinations of 40 persons were conducted during the period June 7-30 of this year. The distribution according to the established classification groups was:

	No. persons
Group 1-A:	14
Group 1-B:	3
Group 1-C:	6
Group 2-A:	3
Group 2-B:	2
Group 3-A:	6
Companions:	6

1.2.1 Medical Monitoring

In the first phase of the Radiological Monitoring Program in the Palomares Zone for 1988 (See Doc. M5A01/PI002/a/88), conducted during the period between 6/7/88 and 6/28/88, 40 persons have been examined medically, broken down as follows:

	No. persons	
Group 1-A:	14	
Group 1-B:	3	
Group 1-C:	6	
Group 2-A:	3	
Group 2-B:	2	
Group 3-A:	6	
Not listed:	6	(companions)

The medical examinations, which were made in accordance with

the instructions set forth in Safety Guide No. 7.4 "Bases for Medical Monitoring of Workers Exposed to Ionizing Radiation" and the recommendations of international organizations, revealed no pathology which might be attributablr to the incorporation of transuranic elements coming from residual contamination of the zone.

We list below all significant findings:

Absence of alterations: 14

Mild alterations: 17

Presence of Pathologies: 9

1. DISEASES OF THE ENDOCRINE GLANDS, NUTRITION AND METABOLISM AND IMMUNITY DISORDERS (24-249)*

Obesity	2
Hyperglycemia	4
Hypercholesterolemia	4
Hypertriglyceridemia	3
Diabetes mellitus Type II	2

2. DISEASES OF THE BLOOD AND HEMATOPOIETIC ORGANS (280-289)

Iron deficiency anemia	1
Eosinophilia	2

3. MENTAL DISORDERS (290-319)

Reduced libido	1
Psychogenic dyspepsia and gastralgia	1
Aerophagia	1

4. DISEASES OF THE NERVOUS SYSTEM AND SENSORY ORGANS (320-389)

Radial neuritis	1
Migraine	1
Reduced visual acuity	1

* ICD Code - 9th revision

Hypermetropia	1
Pterigium	1
Actinic conjunctivitis	1
Allergic conjunctivitis	1
Acute hearing loss	3
Impacted cerumen in the auditory channel	1
Acufenos [?]	2

5. DISEASES OF THE CIRCULATORY SYSTEM (390-459)

Sinus tachycardia with arrhythmia	1
Sinus bradicardia with arrhythmia	1
Pulmonary stenosis	1
Varicose veins, lower extremities	4

6. DISEASES OF THE RESPIRATORY SYSTEM (460-519)

Acute rhinopharyngitis	1
Chronic pharyngitis	1
Chronic asthmatic bronchitis	1
Acute bronchitis	1
Amigdaline hypertrophy	1

7. DISEASES OF THE DIGESTIVE SYSTEM (520-579)

Postcoleocystectomy syndrome	1

8. DISEASES OF THE GENITOURINARY SYSTEM (580-629)

Fibrocystic mastopathy	1
Kidney stones	1

9. DISEASES OF THE SKIN AND SUCUTANEOUS CELLULAR TISSUE (680-709)

Actinic hyperkeratosis	1
Contact dermatitis	1

10. DISEASES OF THE OSTEOMUSCULAR SYSTEM AND CONNECTIVE TISSUE (717-739)

Epicondylitis	1
Gonarthrosis	1
Coxarthrosis	1
Generalized arthrosis	1
Compensatory scoliosis	1
Disseminated arthralgia	3
Cervicpbranchial syndrome	1
Lumbalgia	2
Lumbosciatica	2
Lower limb assymetry (secuela of poliomyelitis)	1

11. POORLY DEFINED SIGNS, SYMPTOMS AND UNHEALTHY CONDITIONS (780-799)

ECG. Right branch blockage	4
ECG. Left atrial hypertrophy	2
ECG. Sinus tachycardia with sinus arrhythmia	1
ECG. Sinus bradicardia with sinus arrhythmia	1
Reduced vital capacity in functional respiratory tests	1
Dysphonia	1
Hyperbilirubinemia	1
Elevated serum transaminase	1
Elevated ureic nitrogen	1
Leukocytes and red corpuscles in urinary sediment	3
Aketonuria	1

The findings listed correspond to the pathology we encounter daily in periodic medical examinations of workers, both exposed and not exposed to ionizing radiation, and in our judgment there is no information which makes us suspect an unhealthy condition

specifically induced by radioactive agents.

1.2.2 Dosimetric Monitoring

With completion of the analyses of urine samples of the 10 persons corresponding to the group of 40 exaqmined during June 1988, it has been determined that both the results corresponding to the measurement of the concentration of Pu-239 + Pu-240 and those corresponding to the measurement of Am-241 have been negative, that is, their values are equal to or lower than the detection limit.

2. ENVIRONMENTAL MONITORING

2.1 GROUND

The following activities have been carried out.

2.1.1 Sampling

In order to study the migration in depth of plutonium and americium in the crop zones, soil sampling was done at depths of between 100 and 150 cm. in a certain portion of parcels 2-0, 3-1 and 3-2 and in the proximity of parcel 2-2. The fact that not all samples were taken at a depth of 150 cm was due to the impssibility of drilling to that depth with the equipment available in some cases, due to hardness of the soil.

To determine the possible dispersion of the plutonium and americium contamination in zones outside the "zero contamination line" established when the accident occurred in 1966, 30 samples of the surface soil to a depth of 5 cm were collected. The samples were collected around the perimeter constituted by the indicated "zero line" and at a distance of some 500 m. from it.

2.1.2 Plutonium and Americium Inventory in Zones 2-0 and 2-1

As indicated in previous reports, the soil samples intended for taking inventory of the plutonium and americium in these zones were collected in 1986. The Am-241 concentration readings at the 37 points sampled (185 samples) were presented in the reports for the seond half of 1986 and the first half of 1987. The Pu-239+Pu-240 concentration readings from the samples corre-

sponding to the 37 points sampled were presented in the report for the second half of 1987.

During this six-month period of 1988, Pu-239 + Pu-240 determinations have proceeded in the remaining soil samples, and the results of an additional 79 additional ones, which correspond to a total of 158 analyses, and which are shown on Table 1. At present, analysis is being made of 6 samples which remain for completion of the 185 collected. These samples, as indicated in previous reports, correspond to 37 points distributed in the area and divided into 5 separate portions to a depth of 45 cm.

As a consequence of the results corresponding to the Am-241 and Pu-239+Pu-240 concentrations specified successively in the previously indicated reports and in this report itself, it is inferred that the plutonium ans americium concentrations are greater in these zones, and especially in the zone we have designated 2-0, than those existing in the rest of the Palomares zone. The total surface of these zones, which comprises hills and the valley between them, is in the order of 4-5 hectares, as specified in our report for the second half of 1986.

The distribution of the plutomium and americium concentrations in these zones, as can be seen on the corresponding tables, is not at all homogeneous. In the valley it is found to be distributed to a depth of 45 cm; in the hills, the concentration below the first layer (5 cm) is one or more orders of magnitude lower.

The estimate of the mean plutonium and americium concentration existing in this zone to a depth of 45 cm, calculated from concentration readings determined permit us to infer that:

- The mean concentration of Pu-239+Pu-240 is in the order of 82 lBq/kg, with a maximum reading of 681 kBq/kg in the vicinity of the impact point of thermonuclear device No. 2, and with a minimum reading of 0.28 kBq/kg at a point in the hills.

- The mean concentration of Am-241 is in the order of 13.4 kBq/kg, with a maximum value of 135 kBq/kg in the vicinity of the cited point of impact of thermonuclear device No. 2, and with a minimum value of 0.10 kBq/kg.

- The ratio between the mean concentrations of plutonium and americium for the entire zone shows a value of 6.1, with partial values which appear to show the existence, depending upon location, of three different values for the Pu/Am ratio, which are 4.7 and 10, with no major deviations. Part of our research task is to determine the causes behind these different values of the plutonium/americium ratios in the soils of the zone.

We consider it appropriate to note that, in this zone, as has been indicated in earlier reports, the most contaminated soil and vegetation collected throughout the area was stored, and later transferred there into 250 liter cans for shipment to the Savannah River Plant in the United States of America.

In accordance with the plutonium and americium concentration readings specified in the respective mentioned tables and with the estimates made of mean concentrations, as indicated before, we observe that the contamination in these zones 2-0 and 2-1 is, as we have said, the greatest in the entire area of Palomares. The estimated mean concentrations of Pu-239 + Pu-240 and of Am-241 are, as we have pointed out earlier, 82 kBq/kg and 13.4 kBq/kg respectively, which signify mean contamination values 40 and 25 times greater, respectively, than those of parcel 2-2, which shows the greater concentration of the rest of the area. The mean concentrations in the 45 cm soil depth stratum of the said parcel 2-2 are: Pu-239+Pu-240 = 2.06 lBq/kg; Am-241 = 0.55 kBq/kg.

Up to the present, this zone has been cultivated only in contained extensions, sporadically and non-continuously. Now, however, in the near future, and due to the nearby construction of an irrigation water reservoir which was placed in operation this summer, the owners of the parcels located in zones 2-0 and 2-1 want to convert them into continuous cultivation lands like the rest of the Palomares area. This conversion might require earth movement. Consequently, it would be desirable that, in the parcels which could not be earmarked for experimentation, the earth removal and its subsequent deposit be done in a controlled fashion and appropriately to ensure that the concentrations of plutonium and

americium in the crop bearing layer (30-40 cm) be in the smallest reasonably attainable values, and not greater in order of magnitude than those of the remainder of the Palomares area.

2.2 AIR

The following activities were carried out during this first half of 1988.

2.2.1 Sampling

Weekly air sampling was conducted at the three stations which are in continuous operation, designated for reference as Stations 2-1, 2-2 and P (urban center). This has involved the collection of 78 air samples, corresponding to a volume of approximately 10 000 m^3 per sample. As already indicated in our previous report, special sampling systems which permit the collection only of aerosol particles having a size of less than 10μm have been operating since July 1987 at Stations 2-2 and P. This is because these particles comprise the truly inhalable component.

The sampling of air in the Santillana (Madrid) Water Reservoir has been continued, with collection of 26 samples during this first half of 1988, corresponding to a mean weekly volume of 300 m^3.

2.2.2 Plutonium Concentration

In accordance with the specifications given in the 1988 Monitoring Program (1), radiochemical analyses have been made during this first six-month period of 46 air samples from Palomares and 62 weekly samples corresponding to the CIEMAT (Madrid) and the Santillana Reservoir (Madrid). The analyses of the Palomar samples were made independently in weekly samples for the periods 3/21/87 - 7/4/87 and 12/12/87 - 1/2/88. The CIEMAT and Santillana Reservoir analyses from the Madrid zone were performed on 4-week compounded samples corresponding to each month, and the continuously cover the period from 2/23/87 to 5/3/88.

The samples analyzed are distributed by location as follows:

Building 2-1: 15 samples, 1987

Building 2-2: 16 samples, 1987
Building P (urban): 15 samples, 1987
CIEMAT building: 29 samples, 1987
Santillana R. Building: 33 samples, 1987-1988

The results of the radiochemical analysis of the measurements by alpha spectrometry of the aerosol samples taken in the Palomares zone are shown on Tables 2 and 3; Table 2 shows the final readings corresponding to the period prior to the installation, at stations 2-2 and P, of the sampling systems permitting collection of particles only smaller than 10μm.

The results correponding to the Madrid zone are specified in Table 4.

It is inferred from the readings shown in Table 2, that the mean values of plutonium concentrations in the Palomares zone are as shown below:

Pu-239 + Pu-240 Concentration

Period: 3/21/87 to 7/4/87
Buildimg 2-1: 382 μBq/m³
Building 2-2: 135 "
Building P (urban): 29.6 "

It is appropriate to consider the major effect that the values which we can consider episodic, and which correspond, inter alia, to the maximums determined, have on the mean concentrations. As can be seen these values are 4491 μBq/m³ in Building 2-1, 677 μBq/m³ in Building 2-2 and 224 μBq/m³ in Building P. When we have available a larger number of results corresponding to the samples of particles smaller than 10 μm, we will be able to infer whether these episodic values are, or are not the consequence of isolated "hot particles".

Nevertheless, both these mean values and the weekly values specified on Tables 2 and 3 for each of the sampling stations, are below the limit derived concentration in air (5 900 μBq/m³) for Class Y plutonium compounds, as can be inferred from the value established in the Spanish legislation (2) for the annual incorporation by inhalation.

From the values specified in Table 4, it is inferred that the mean values of the Pu-239 + Pu- 240 concentration in the Madrid zone have been below 0.2 μBq/m³ during the period 2/23/87 to 5/3/88. This permits us to infer that, during the indicated period of time, the concentration of Pu-239 + Pu-240 due to radioactive fallout in Spain is below 0.2 μBq/m³.

2.2.3 Americium concentration

The activities carried out in this regard fave been in accordance with the specifications given in the 1988 Monitoring Program (1). Radiochemical analyses and alpha spectrometry measurements have been made of a total of 33 weekly samples from Palomares and 27 weekly samples corresponding to the Santillana Reservoir (Madrid), to determine the concentration of Am-24 in the air. The Palomares zone analyses were made independently in weekly samples; the analyses from the Madrid zone were performed on 4-week compounded samples corresponding to each month, with the exception of one which represents only one week.

The samples analyzed are distributed by location as follows:

Building 2-1: 12 samples, 1987
Building 2-2: 6 samples, 1987
Building P (urban): 15 samples, 1987
Santillana R. Building: 27 samples, 1987-1988

The results of the determinations from the analyses carried out on the samples from the Palomares zone are shown on Table 5. From the values shown on this table, it has been inferred that these mean values of the Am-241 concentrations which correspond to each station of the Palomares zone during the period 3/21/87 to 7/4/87 are:

	Am-241 Concentration
Buildimg 2-1:	3.6 μBq/m³
Building 2-2:	1.7 "
Building P (urban):	≤ 0.2 "

Both these mean values of the Am-241 concentrations in air and each of the values specified on Table 5, are below the limit of the derived concentration in air (2 360 μBq/m³) for all Am-241

compounds for the standard mean man of the population, as can be inferred from the value established in the Spanish legislation (2) for the annual incorporation by inhalation. Consequently, the risk derived from its inhalation can be considered to be negligible, as a practical matter.

The results of the determinations corresponding to the sampling carried out in the Madrid area (Santillana Reservoir) are shown on Table 6. From these values it is inferred that the Am-241 concentration in the radioactive fallout for Spain is less than 0.2 $\mu Bq/m^3$.

2.3 VEGETATION

The following activities carried out in this regard during the first half of 1988:

2.3.1 Sampling

Following the specifications established in the Monitoring Plan for 1988 (1), the following vegetation samples were taken:

- 10 tomato samples and 10 tomato plant samples from the Zone 3 greenhouses. They were collected during April.
- 8 barley samples representative of the crop of this cereal. These were collected during May in Zones 2, 3 and 5. For its analysis, each sample was subdivided into grain, straw and spike.
- 3 wheat samples from Zones 2, 3 and 5. Each was subdivided for analysis, into grain,straw and spike.
- 9 water melon samples and 9 samples of water melon plants representative of this fruit's crop, from Zones 2, 3 and 5. The water melon crop has become a very important economic factor for the area this year.

2.3.2 Americium Contamination

Determination of Am-241 contamination was made in 65 vegetation samples from 1987 and 1988, which brings the total number of analyses to 130. With this the analysis of samples collected in 1987 was completed.

These determinations correspond to:

- 9 barley samples from 1987

- 2 wheat samples from 1987
- 1 olive tree sample from 1987
- 10 tomato samples from 1987

In the cereal samples Am-241 contamination was determined separately for the grain, spike and straw; in the olive samples. both fruit and leaves were analized; in those of tomatoes, the measurements were made in the washed and unwashed fruit and in the plant leaves.

The results of the determinations made on these samples are shopwn on Tables 7 through 12. The results of the other vegetation samples collected in 1987 were given in the report for the second half of 1987 (3). From the values shown on Tables 7 through 12, it is inferred that:

- The samples of barley grown during 1987 on Zone 2-0 generally present Am-241 contamination. Contamination was found in the 3 straw samples, the 3 spike samples and 1 of the grain samples.

The mean values corresponding to the samples which have showed concentrations greater than the minimums detectable by our method are:

Grain:	5.3	Bq/kg
Spike:	354	"
Straw:	20.1	"

- Of the barley samples grown during 1987 in the rest of Zone 2, Am-241 contamination was found only in one of straw; the concentration determined was 1.3 ± 11% Bq/kg.

- The samples of barley grown during 1987 in Zones 3 and 5 showed no Am-241 contamination in any of their parts.

- The wheat samples collected in 1987 in Zones 2-0 and 5 showed no Am-241 contamination greater than the limits detectable by our method.

- The olive fruit sample collected in 1987 showed no Am-241 contamination, while the leaves were determined to have a concentration of 17.7 ± 2% Bq/m^3.

- The samples of washed and unwashed tomatoes and tomato

leaves corresponding to the crops grown in greenhouses during 1988 were found to have no Am-241 contamination, except for one unwashed tomato sample from Zone 3, which showed a value of 0.23 ± 0.04 Bq/kg.

The significance of the concentration readings obtained, from the point of view of hazards to persons can be inferred by comparing the values specified with the official limit of annual incorporation by ingestion, which is 5 000 Bq (2), and with the transfer factors for ingestion ($\approx 10^{-4}$) in animals, of the products used for food.

2.3.3 Soil-Plant Concentration Ratios for Plutonium

From the values for plutonium contamination of many tomato samples (fruit and plant), barley (grain, straw and spike) and alfalfa collected over the years in different areas of Palomares and from those of the mean contamination of the ground in which they have been grown, and which also pertain to many determinations, we have made the necessary calculations to determine, for field experimentation, the values of the very significant parameter of the soil/plant ratio under the farming conditions which apply to the Palomares area and for the characteristics of its soil.

The values obtained are specified on Table 13 and were made a part of the paper we presented in March 1988 in the IV International Radioecology Symposium which was held in Cadarache, France on the subject of "The Impact of Nuclear Origin Accidents on Environment". This paper, entitled "EVALUATION OF REMEDIAL ACTIONS TAKEN IN AN AGRICULTURAL AREA CONTAMINATED BY TRANSURANIDES" was prepared by Emilio Iranzo, Asunción Espinosa and C. Emma Iranzo.

From the values specified in the indicated Table 13 and those shown on Table 14, which correspond to the plutonium concentrations determined over a period of time in the indicated agricultural products, it has been inferred, as expounded in the cited paper that:

- In farming areas with a Mediterranean climate and weak rainfall, external surface plutonium contamination, by reason of

resuspension, plays an important role in the contamination of cultivated products.

- The values of soil/plant concentration ratio are in the order of 10^{-4} for tomatoes and 10^{-3} for tomato plants and the various components of barley and alfalfa.

2.3.4 Derived Doses from Crop Products

Based upon the soil/plant plutonium concentration ratios determined in the field for the crops in Palomares and the annual productivity of each type crop in that area, we have calculated the effective overall collective dose equivalent which would result from direct or indirect ingestion of the annual crop produced in each hectare of the zone which presents the maximum soil contamination. In order to adopt the most conservative posture from the radiological protection point of view, we have assumed the entire crop to be contaminated, although we have verified that this is not the case, as can be inferred from Table 14.

The values calculated for the indicated effective overall collective dose equivalent are shown on Table 15.

These values were calculated in consideration of:

- Transfer factors to milk and meat by reason of animal ingestion of contaminated products specified in the TERRA Code (4).
- Highest values of the Sv/Bq ingestion ratio (5) for estimating the effective overall dose equivalent in 70 years for individuals of different ages.
- Tomato, barley and alfalfa crops grown in soil having a Pu-239 + Pu-240 concentration in the order of 2.1 kBq/kg^{-1}.

It can be observed from the values specified on Table 1 that:

- The effective overall collective dose equivalent resulting from direct consumption of the tomatoes grown on 1 Ha would be, as a maximum, 3×10^{-3} man/Sv.
- The effective overall individual dose equivalent would be a maximum of 1.5 μSv per year.
- The effective overall collective dose equivalent resulting from consumption of milk produced by cows fed with the barley

produced annually would be, as a maximum, 3.6×10^{-10} man/Sv for children one year of age and 1.2×10^{-10} man/Sv for adults.

- The effective overall collective dose equivalent resulting from consumption of beef from cows which were fed with the barley produced annually on 1 Ha would be, as a maximum, 1.2×10^{-9} man/Sv for children 5 years of age and 6.0×10^{-10} for adults.

- The effective overall collective dose equivalent resulting from consumption of beef from cows fed with the straw produced annually on 1 Ha would be, as a maximum, 2.7×10^{-9} man/Sv for children 5 years of age and 1.3×10^{-9} man/Sv for adults.

- The effective overall collective dose equivalent resulting from consumption of milk produced by cows which were fed with the alfalfa produced annually on 1 Ha would be, as a maximum, 4.7×10^{-9} man/Sv for children 1 year of age and 1.6×10^{-9} for adults.

- The effective overall collective dose equivalent resulting from consumption of beef from cows fed with the alfalfa produced annually on 1 Ha would be, as a maximum, 1.6×10^{-8} man/Sv for children 5 years of age and 7.9×10^{-9} man/Sv for adults.

This study is also included in the paper which was delivered at the IV International Radioecology Symposium held in Cadarache in March 1988, the title and authors (6) of which are indicated in the previous section.

2.4 ANIMALS

2.4.1 Sampling

The activities carried out in this area during this quarter [sic] have consisted of the collection of 4 milk samples from one of the goats acquired, which foraged all year throughout all the areas in Palomares. The other goat died last year, as we indicated in our report for the second half of 1987 and the kid delivered by one of these goats, which feeds in the same pasture area, has still given no milk.

Each of the milk samples is a weekly and representative compound of the daily milkings.

2.4.2 Plutonium Contamination in Animal Tissues

During this six-month period we incinerated the

animal tissues (flesh, bones and feathers) of the 10 chickens bred during 1987 (3) in a poultry yard near Parcel 2-2.

Radiochemical analyses and alpha spectrometry measurements were made to determine the Pu-239 + Pu-240 concentration in the ashes corresponding to 8 samples. The readings from these determinations are shown on Table 16. From the values given on the table, it is inferred that:

- There is no Pu-239 + Pu-240 contamination in the gizzard or in the flesh of the extremities or body of the chicken samples which have been analyzed to date. The measurements show no concentrations in excess of the detectable minimums of the method utilized.

- The two feather samples analyzed present Pu-239 + Pu-240 contamination with respective concentrations of 646 and 255 mBq/kg, which, in our judgment are the consequence of external contamination due to life style and the fact that they were bred with full freedom to move about, both in, and outside the poultry yard, where the plutonium soil contamination is of the order specified in the report corresponding to Parcel 2-2.

3. PARTICIPANTS

The following CIEMAT personnel have participated in the activities which led to obtaining the data, conclusions and specifications set forth in this report:

Senior technicians: Emilio Iranzo, Alicia Alvarez, Angel Bellido, Santiago Castaño, M. Asunción Espinosa and C. Emma Iranzo.

Technicians: Camila Blanco, Ludivina Borrego, Mariano Casado, M. Carmen Guzman, José M. Montero, Francisco Moreno and Mariano Moya.

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TABLE 1. Pu 239 + Pu-240 RADIOACTIVITY CONCENTRATION IN THE SOIL OF ZONES 2-0 and 2-1. 1986.

② PUNTO	③ POSICION	④ CONCENTRACION DE ^{239}Pu + ^{240}Pu, kBq/kg				
		0 - 5 cm	5-15 cm	15 - 25 cm	25-35 cm	35-45 cm
1	(270.117)	1030 ± 154	752 ± 112	925 ± 138		193 ± 29
2	(300.110)	57.1 ± 8.6	39.0 ± 5.9	71.5 ± 10.7	15.9 ± 2.4	
3	(287.100)	877 ± 132	498 ± 75	336 ± 50	171 ± 26	422 ± 63
4	(330.100)					
5	(285.90)	113 ± 17	196 ± 20	97.6 ± 14.6		40.4 ± 6.1
6	(271.90)	1.76 ± 0.26				
7	(310.90)	16.2 ± 2.4				
8	(297.70)	127 ± 19	325 ± 49	307 ± 46	9.09 ± 1.36	
9	(330-70)	3.4 ± 0.5				0.41 ± 0.06
10	(290-50)	109 ± 16	89.3 ± 13.4			
11	(285-30)	94.7 ± 14.2	76.0 ± 11.4			
12	(290-123)	91.4 ± 13.7	121 ± 8	73.3 ± 11.0	77.7 ± 11.7	
13	(320-123)					
14	(310.145)	299 ± 45				
15	(250.145)	245 ± 22	27.9 ± 4.2	427 ± 64	304 ± 46	

2- POINT; 3- POSITION; 4- Pu-239 + Pu 240 CONCENTRATION, kBq/kg

TABLE 1. Pu 239 + Pu-240 RADIOACTIVITY CONCENTRATION IN THE SOIL OF ZONES 2-0 and 2-1. 1986.

PUNTO (2)	POSICION (3)	(4) CONCENTRACION DE ^{239}Pu + ^{240}Pu, kBq/kg				
		0 - 5 cm	5-15 cm	15 - 25 cm	25-35 cm	35-45 cm
16	(260.145)	4.36 ± 0.65				
17	(280.160)	88.6 ± 13.3				
18	(300.160)	382 ± 57	774 ± 116	211 ± 31	29.1 ± 4.4	
19	(310.160)	381 ± 57	249 ± 37	81.7 ± 12.3		
20	(320.160)					
21	(310.180)		50.8 ± 7.6	276 ± 41		
22	(300.180)	552 ± 83	43.8 ± 6.6			79.5 ± 11.3
23	(280.180)	51.3 ± 7.8	43.9 ± 6.6			
24	(285.200)	6.40 ± 0.96		1.25 ± 0.19		
25	(300.200)					
26	(320.200)	78.5 ± 11.9			0.63 ± 0.07	
27	(310,225)	97.1 ± 14.6	81.9 ± 12.3	75.2 ± 11.5	345 ± 52	
28	(300.225)	81.3 ± 12.2	78.0 ± 11.7		23.2 ± 3.5	
29	(290.225)	20.5 ± 3.1		1.69 ± 0.25		
30	(325.225)	33.4 ± 5.0	78.4 ± 11.8	253 ± 37	110.1 ± 16.5	

2- POINT; 3- POSITION; 4- Pu-239 + Pu 240 CONCENTRATION, kBq/kg

TABLE 1. Pu 239 + Pu-240 RADIOACTIVITY CONCENTRATION IN THE SOIL OF ZONES 2-0 and 2-1. 1986.

PUNTO (2)	POSICION (3)	(4) CONCENTRACION DE ^{239}Pu + ^{240}Pu, kBq/kg				
		0 - 5 cm	5-15 cm	15 - 25 cm	25-35 cm	35-45 cm
31	(335.225)	382 ± 57				
32	(300.240)			94.4 ± 14.2		
33	(360.240)					
34	(290.270)		26.5 ± 4.0	92.1 ± 13.8		51.0 ± 7.7
35	(330.270)	461 ± 69				
36	(350.300)	471 ± 71				
37	(325.340)	263 ± 39				

2- POINT; 3- POSITION; 4- Pu-239 + Pu 240 CONCENTRATION, kBq/kg

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TABLE 2

Pu-239 + Pu-240 RADIOACTIVITY CONCENTRATION IN PALOMARES AIR SAMPLES

(4) PERIODO	(5) CONCENTRACION DE Pu-239 + Pu-240 ($\mu Bq/m^3$)		
	(6) CASETA 2-1	(7) CASETA 2-2	(8) CASETA P (zona urbana)
21-03-87 al 28-03-87	35.0 ± 5.4	30.8 ± 4.8	21 ± 3.5
28-03-87 al 04-04-87	60.3 ± 6.6	26.6 ± 4.1	32.1 ± 5.3
04-04-87 al 11-04-87	51.6 ± 3.3	16.0 ± 2.5	15.5 ± 2.5
11-04-87 al 18-04-87	48.2 ± 8.6	224 ± 34	6.8 ± 1.1
18-04-87 al 25-04-87	40.2 ± 6.8	46.5 ± 9.3	3.5 ± 0.6
25-04-87 al 02-05-87	53.2 ± 5.8		224.0 ± 39.1
02-05-87 al 09-05-87	60.1 ±10.2	43.4 ± 8.4	3.5 ± 0.6
09-05-87 al 16-05-87	3.6 ± 0.5	676.6 ±102.9	0.7 ± 0.08
16-05-87 al 23-05-87	70.6 ±11.3		78.7 ± 12.1
23-05-87 al 30-05-87	11.4 ± 1.2	37.1 ± 6.6	14.9 ± 2.2
30-05-87 al 06-06-87	26.9 ± 4.2	22.6 ± 3.6	6.9 ± 1.23
06-06-87 al 13-06-87	16.2 ± 1.9	81.8 ± 2.9	17.2 ± 2.8
13-06-87 al 20-06-87	4491.3 ±46.9	442 ± 83.8	10.6 ± 0.2
20-06-87 al 27-06-87		72.4 ± 11.2	6.2 ± 0.9
27-06-87 al 04-07-87		35.1 ± 5.8	2.4 ± 0.47

4- PERIOD; 5- Pu-239 + Pu-240 CONCENTRATION ($\mu Bq/m^3$)

6- BUILDING 2-1; 7- BUILDING 2-2; 8- BUILDING P (urban zone)

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TABLE 3

Pu-239 + Pu-240 RADIOACTIVITY CONCENTRATION IN PALOMARES AIR SAMPLES

④ PERIODO	⑤ CONCENTRACION DE Pu-239 + Pu-240 ($\mu Bq/m^3$)		
	⑥ CASETA 2-1	⑦ CASETA 2-2	⑧ CASETA P (zona urbana)
12-12-87 al 19-12-87	1.1 ± 0.25	40.5 ± 4.3	
19-12-87 al 26-12-87		1.4 ± 0.3	
26-12-87 al 02-01-88	3.0 ± 0.5	7.5 ± 1.0	

4- PERIOD; 5- Pu-239 + Pu-240 CONCENTRATION ($\mu Bq/m^3$)

6- BUILDING 2-1; 7- BUILDING 2-2; 8- BUILDING P (urban zone)

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TABLE 4

Pu-239 + Pu-240 RADIOACTIVITY CONCENTRATION IN PALOMARES AIR SAMPLES

(4) PERIODO	(5) CONCENTRACION DE Pu-239 + Pu-240 ($\mu Bq/m^3$)		
	C I E M A T	HIDRAULICA DE SANTILLANA (9)	
23-02-87 al 02-03-87	≤ 0.2		
02-03-87 al 30-03-87	≤ 0.2		
30-03-87 al 27-04-87	≤ 0.2		
27-04-87 al 04-05-87	≤ 0.2		
04-05-87 al 01-06-87	≤ 0.2		
01-06-87 al 30-06-87	≤ 0.2		
30-06-87 al 28-07-87	≤ 0.2		
28-07-87 al 04-08-87	≤ 0.2		
04-08-87 al 01-09-87	≤ 0.2		
01-09-87 al 14-09-87	≤ 0.2		
15-09-87 al 29-09-87		≤ 0.2	
29-09-87 al 27-10-87		≤ 0.2	
27-10-87 al 03-11-87		≤ 0.2	
03-11-87 al 01-12-87		≤ 0.2	
01-12-87 al 29-12-87		≤ 0.2	
05-01-08 al 26-01-87		≤ 0.2	
26-01-88 al 01-03-88		≤ 0.2	
01-03-88 al 05-04-88		≤ 0.2	
05-04-88 al 03-05-88		≤ 0.2	

4- PERIOD; 5- Am-241 CONCENTRATION ($\mu Bq/m^3$)

9- SANTILLANA RESERVOIR

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TABLE 5

Am-241 RADIOACTIVITY CONCENTRATION IN PALOMARES AIR SAMPLES.

(4) PERIODO	(5) CONCENTRACION DE Am-241 ($\mu Bq/m^3$)		
	(6) CASETA 2-1	(7) CASETA 2-2	(8) CASETA P (zona urbana)
21-03-87 al 28-03-87	10.4 ± 1.2		≤ 0.2
28-03-87 al 04-04-87	4.8 ± 0.5	≤ 0.2	≤ 0.2
04-04-87 al 11-04-87	3.2 ± 0.4	2.7 ± 0.4	≤ 0.2
11-04-87 al 18-04-87	0.8 ± 0.1	0.7 ± 0.1	≤ 0.2
18-04-87 al 25-04-87	5.6 ± 0.7	≤ 0.2	≤ 0.2
25-04-87 al 02-05-87	≤ 0.2		≤ 0.2
02-05-87 al 09-05-87	3.9 ± 0.7	6.4 ± 0.9	≤ 0.2
09-05-87 al 16-05-87	1.2 ± 0.3	≤ 0.2	≤ 0.2
16-05-87 al 23-05-87	3.5 ± 0.5		≤ 0.2
23-05-87 al 30-05-87	0.8 ± 0.1		≤ 0.2
30-05-87 al 06-06-87	3.2 ± 0.5		≤ 0.2
06-06-87 al 13-06-87	5.6 ± 0.8		≤ 0.2
13-06-87 al 20-06-87			≤ 0.2
20-06-87 al 27-06-87			≤ 0.2
27-06-87 al 04-07-87			≤ 0.2

4- PERIOD; 5- Am-241 CONCENTRATION ($\mu Bq/m^3$);

6- BUILDING 2-1; 7- BUILDING 2-2; 8- BUILDING P (urban zone)

9- SANTILLANA RESERVOIR

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TABLE 6.

Am-241 RADIOACTIVITY CONCENTRATION IN PALOMARES AIR SAMPLES

(4) PERIODO	(5) CONCENTRACION DE Am-241 ($\mu Bq/m^3$)		
	CIEMAT	HIDRAULICA DE SANTILLANA (9)	
23-02-87 al 02-03-87	-----		
02-03-87 al 30-03-87	-----		
30-03-87 al 27-04-87	-----		
27-04-87 al 04-05-87	-----		
04-05-87 al 01-06-87	-----		
01-06-87 al 30-06-87	-----		
30-06-87 al 04-08-87	-----		
04-08-87 al 01-09-87	-----		
01-09-87 al 14-09-87	-----		
15-09-87 al 29-09-87		-----	
29-09-87 al 27-10-87		-----	
27-10-87 al 03-11-87		$\leq$ 0.2	
03-11-87 al 01-12-87		$\leq$ 0.2	
01-12-87 al 29-12-87		$\leq$ 0.2	
05-01-86 al 26-01-86		$\leq$ 0.2	
26-01-86 al 01-03-86		$\leq$ 0.2	
01-03-86 al 05-04-86		$\leq$ 0.2	
05-04-86 al 03-05-86		$\leq$ 0.2	

4- PERIOD; 5- Am-241 CONCENTRATION ($\mu Bq/m^3$);

6- BUILDING 2-1; 7- BUILDING 2-2; 8- BUILDING P (urban zone)

9- SANTILLANA RESERVOIR

TABLE 7 AMERICIUM - 241 CONTENT IN THE VEGETATION OF AREA 2-O DURING 1987

SAMPLING DATE	FARM	VEGETABLE		RADIOACTIVITY CONCENTRATION
		Species	Part	
26-4	P.T (300 / 275)	① Cebada	② Grano	≤0.011
"	"	"	③ Espícula	5.2 ± 5%
"	"	"	④ Paja	1.4 ± 16%
14-5	A.N.N.(300 / 200)	"	② Grano	≤ 0.006
"	"	"	③ Espícula	132.7± 1%
"	"	"	④ Paja	14.9 ± 2%
"	A.N.N.(300 / 220	"	② Grano	5.3 ± 3%
"	"	"	③ Espícula	924.1± 1%
"	"	"	④ Paja	44.0 ± 1%
26-4	A.P.M.(350 / 325)	⑤ Trigo	② Grano	≤ 0.006
"	"	"	③ Espícula	≤ 0.006
"	"	"	④ Paja	≤0.007

Key: 1) Barley; 2) Grain; 3) Spike; 4) Straw; 5) Wheat.

TABLE 8 AMERICIUM - 241 CONTENT IN THE VEGETATION OF AREA 2 DURING 1987

SAMPLING DATE	FARM	VEGETABLE		RADIOACTIVITY CONCENTRATION
		Species	Part	
26-4	M.N.A. $\binom{700}{825}$	(1) Cebada	(2) Grano	≤ 0.010
"	"	"	(3) Espícula	≤ 0.006
"	"	"	(4) Paja	$1.3 \pm 11\%$
"	M.P.P. $\binom{500}{750}$	"	(2) Grano	≤ 0.007
"	"	"	(3) Espícula	≤ 0.006
"	"	"	(4) Paja	≤ 0.007
14-1	M.S.N $\frac{550}{775}$	(6) Olivo	(7) Fruto	≤ 0.007
"	"	"	(8) Hojas	$17.7 \pm 2\%$

Key: 1) Barley; 2) Grain; 3) Spike; 4) Straw; 6) Olive tree; 7) Fruit; 8) Leaves.

TABLE 9 AMERICIUM - 241 CONTENT IN THE VEGETATION OF AREA 3
DURING 1987

SAMPLING DATE	FARM	VEGETABLE		RADIOACTIVITY CONCENTRATION
		Species	Part	
26-4	J.C.G (CAT 761)	① Cebada	② Grano	⩽ 0.010
"	"	"	③ Espícula	⩽ 0.007
"	"	"	④ Paja	⩽ 0.006
"	D.C.G (CAT 765)	"	② Grano	⩽ 0.006
"	"	"	③ Espícula	⩽ 0.006
"	"	"	④ Paja	⩽ 0.007

Key: 1) Barley; 2) Grain; 3) Spike; 4) Straw.

TABLE 10 AMERICIUM - 241 CONTENT IN THE VEGETATION OF AREA 5 DURING 1987

SAMPLING DATE	FARM	VEGETABLE		RADIOACTIVITY CONCENTRATION
		Species	Part	
14-5	D.P.G. Parcela 5-1	(1) Cebada	(2) Grano	⩽ 0.006
"	"	"	(3) Espícula	⩽ 0.006
"	"	"	(4) Paja	⩽ 0.009
26-4	P.C.P. (1300 / 800)	"	(2) Grano	⩽ 0.006
"	"	"	(3) Espícula	⩽ 0.005
"	"	"	(4) Paja	⩽ 0.006
"	J.A.A. (1600 / 1150)	(5) Trigo	(2) Grano	⩽ 0.006
"	"	"	(3) Espícula	⩽ 0.005
"	"	"	(4) Paja	⩽ 0.006

Key: 1) Barley; 2) Grain; 3) Spike; 4) Straw; 5) Wheat.

TABLE 11 AMERICIUM - 241 CONTENT IN THE VEGETATION OF AREA 2 DURING 1988

SAMPLING DATE	FARM	VEGETABLE		RADIOACTIVITY CONCENTRATION
		SPECIES:	PART:	Bq/kg
24-4	Invernadero Este G.S.G (725,750)	(10) Tomate	(7) Fruto	⩽0.007
"	"	"	Fruto lavado (11)	⩽0.007
"	"	"	(12) Planta	⩽0.005
"	Invernadero Sur J.S.F.(975,750)	"	(7) Fruto	⩽0.007
"	"	"	Fruto lavado (11)	⩽0.007
"	"	"	(12) Planta	⩽0.005
"	Invernadero Norte J.S F.(950,850)	"	(7) Fruto	⩽0.006
"	"	"	Fruto lavado (11)	⩽0.006
"	"	"	(12) Planta	⩽0.006
"	Invernadero Este F.L.L.(700,550)	"	(7) Fruto	⩽0.006
"	"	"	Fruto lavado (11)	⩽0.007
"	"	"	(12) Planta	⩽0.006
"	Invernadero Oeste F.L.L.(600,550)	"	(7) Fruto	⩽0.007
"	"	"	Fruto lavado (11)	⩽0.006
"	"	"	(12) Planta	⩽0.005

Key: 7) Fruit; 10) Tomato; 11) Washed Fruit; 12) Plant.

TABLE 12 AMERICIUM - 241 CONTENT IN THE VEGETATION OF AREA 3 DURING 1988

SAMPLING DATE	FARM	VEGETABLE		RADIOACTIVITY CONCENTRATION Bq/kg
		SPECIES:	PART:	
24-4	Invernadero Norte J.A.L.(CAT 488)	(10) Tomate	(7) Fruto	⩽ 0.006
"	"	"	(11) Fruto lavado	⩽ 0.007
"	"	"	(12) Planta	⩽ 0.006
"	Invernadro Oeste J.N.T. (CAT 228)	"	(7) Fruto	⩽ 0.008
"	"	"	(11) Fruto lavado	⩽ 0.007
"	"	"	(12) Planta	⩽ 0.006
"	Invernadero Este J.N.T. (CAT 228)	"	(7) Fruto	⩽ 0.007
"	"	"	(11) Fruto lavado	⩽ 0.007
"	"	"	(12) Planta	⩽ 0.006
"	Invernadero Norte J.N.T. (CAT 498)	"	(7) Fruto	⩽ 0.007
"	"	"	(11) Fruto lavado	⩽ 0.007
"	"	"	(12) Planta	⩽ 0.007
"	Invernadero Sur J.N.T. (CAT 498)	"	(7) Fruto	0.23 ± 0.04
"	"	"	(11) Fruto lavado	⩽ 0.007
"	"	"	(12) Planta	⩽ 0.006

Key: 7) Fruit; 10) Tomato; 11) Washed Fruit; 12) Plant.

TABLE 13. PLUTONIUM SOIL/PLANT CONCENTRATION RATIOS

PLANTA (2)		RELACION DE CONCENTRACION (3)
(4) ESPECIES	(5) PARTE	
TOMATES	FRUTO	1.5×10^{-4}
"	FRUTO LAVADO	0.9×10^{-4}
"	PLANTA	2.3×10^{-3}
CEBADA	GRANO	1.9×10^{-3}
"	PAJA	5.0×10^{-3}
"	ESPÍCULA	6.2×10^{-3}
ALFALFA	(6) COMESTIBLE	8.9×10^{-3}

2- PLANT; 3- CONCENTRATION RATIO; 4- SPECIES; 5- PART

6- EDIBLE

TABLE 14. PLUTONIUM CONCENTRATION IN AGRICULTURAL PRODUCTS GROWN IN PALOMARES

PLANTA (2)		(3) Nº DE MUESTRAS		(4) CONC. Pu. Bq x Kg^{-1}
(5) ESPECIES	PARTE (6)	TOTAL (7)	% POSITIVAS (8)	(9) $\bar{X}$ EN POSITIVAS
TOMATE	FRUTO	159	28.3	0.22
TOMATE	FRUTO LAVADO	231	6.1	0.15
TOMATE	PLANTA	206	41.7	4.42
CEBADA	GRANO	496	26.8	2.47
CEBADA	PAJA	496	37.0	5.87
CEBADA	ESPÍCULA	144	58.3	5.38
ALFALFA	PLANTA	112	39.0	3.33

2- PLANT; 3- NO OF SAMPLES; 4- PU CONC. Bq x Kg^{-1}
5- SPECIES; 6- PART; 7- TOTAL 8- % POSITIVE 9- X IN THOSE POSITIVE

TABLE 15. EFFECTIVE OVERALL COLLECTIVE DOSE EQUIVALENT BY INGESTION OF FOODS DERIVED FROM CONSUMPTION OF ANNUAL CROPS PER HECTARE GROWN IN SOILS WITH A PLUTONIUM CONCENTRATION OF 2.1 kBq/ KG^{-1}

(2) COSECHA			Tomato	Barley		ALFALFA
				Grain	Straw	
$Pu^{239} + Pu^{240}$ (3) EN COSECHA ANUAL Bq x Ha^{-1} x Año-1			25.2×10^{3}	9.98×10^{3}	23.1×10^{3}	130.8×10^{3}
(4) CONSUMO DIRECTO $S_{E,70}$ (HOMBRE (13) - Sv)		(5) ADULTOS	3.02×10^{-5}			
		(6) 5 AÑOS	6.05×10^{-5}			
(7) CONSUMO INDIRECTO $S_{E,70}$ (13) (HOMBRE-Sv)	(8) CARNE	ADULTOS		6.0×10^{-10}	1.3×10^{-8}	7.9×10^{-8}
		5 AÑOS (10)		12.0×10^{-10}	2.7×10^{-8}	15.7×10^{-8}
	(9) LECHE	ADULTOS (11)		1.2×10^{-10}	2.8×10^{-10}	1.6×10^{-8}
		1 AÑO (12)		3.6×10^{-10}	8.32×10^{-10}	4.7×10^{-8}

2- C R O P 3- IN ANNUAL HARVEST 4- DIRECT CONSUMPTION; 5- ADULTS; 6- 5 YRS; 7- DIRECT CONSUMPTION; 8- MEAT; 9- MILK; 10- ADULTS; 11- 5 YRS; 12- 1 yr; 13- MAN/Sv

TABLE 16. PLUTONIUM CONCENTRATION IN CHICKEN TISSUES, 1987.

② MUESTREO	③ TEJIDO	④ CONCENTRACION DE Pu-239+Pu-240(mBq/kg)
21/10	⑤ MOLLEJAS(10 POLLOS)	⩽5.2
	⑥ MUSCULO EXTREMIDADES	
"	POLLO Nº 1	⩽1.7
"	POLLO Nº 2	⩽1.5
"	POLLO Nº 3	⩽5.2
	⑦ MUSCULO CUERPO	
"	POLLO Nº 2	⩽ 19.9
"	POLLO Nº 3	⩽ 13.7
	⑧ PLUMAS	
"	POLLO Nº 1	646
"	POLLO Nº 3	255

2- SAMPLING; 3- TISSUE; 4- CONCENTRATION OF

5- GIZZARDS (10 chickens); 6- MUSCLE extremities; 7- MUSCLE body; 8- FEATHERS [pollo = chicken]